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The Next Generation of Combat Casualty Care

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With many new faces and multiple changes in the military research leadership, right now is a perfect time to reassess combat casualty care research and our goals for the "next generation." Since September 11, 2001, we have made huge strides in combat casualty care, with advances in the design and deployment of tourniquets and hemostatic dressings, implementation of damage control resuscitation (DCR) and the joint theater trauma system (JTTS), and improvements in burn and tactical combat casualty care. By addressing some of the most pressing research issues confronting us at the start of Operation Enduring Freedom, we have reinforced the foundation of combat casualty care, and as we have witnessed improved outcomes for our wounded warriors, we have built momentum. So, now we must ask ourselves, "where do we go from here?"

Beyond Tourniquets

The technology, efficacy, and availability of tourniquets on the battlefield have all been enhanced. Many lives have been saved with the use of this simple tool, and hemorrhage of the extremities is no longer the leading cause of potentially preventable death. Hemorrhage in the groin and shoulder, however, represents up to 20% of deaths on the battlefield. Accordingly, in our next generation of research we must find methods to mechanically address "compressible non-tourniquetable" hemorrhage. The fact that we have not advanced the anatomic geography of potentially and mechanically compressible arterial hemorrhage by a single millimeter in 400 years serves as a stark reminder of this particular need.

Hemostatic Dressings

Before the current conflicts—in fact, for all of recorded human history—cloth dressings were the sole instrument to stop bleeding in battlefield wounds. With the advent of the Hemcon dressing and the Quikclot hemostatic agent, an exciting area of combat casualty care research was added to the medic's armentarium. This area of research will continue to be a dynamic and an iterative process as these agents continue to improve. We must continue to tirelessly test new agents to provide the best hemostatic agents on the battlefield.

The Challenges of DCR

DCR follows the simple principle of replacing what the combat wounded is losing (i.e., massive amounts of blood), with blood products that more closely reflect the components of whole blood. It has been associated with improved survival in combat wounded at robust surgical facilities (level III) and is now used at all US Army surgical facilities including forward surgical teams – even FST split operations.

Deployment of DCR will be enhanced with sensitive and rapid detection of blood borne pathogens and a back-up plan for viral elimination for the lifesaving fresh whole blood used as the sole source of platelets and clotting factors in many austere surgical platforms. Because of global transport of blood and blood products, ways to ameliorate the deleterious effects of age on blood must be pursued. We must look at freezing and new preservative preparations for packed red cells. Moreover, we must push DCR "to the left on to the battlefield . . . and the right into the ICUs." We suspect that the intravenous fluids currently used on the battlefield may actually increase bleeding by diluting clotting factors and raising blood pressure, and we must do better. We need to extend DCR to the combat wounded who are actively bleeding (e.g., from truncal penetrating injury), beginning at the site of injury and tactical evacuation to the battalion aid station (level I). Subsequently, DCR will need to be pushed to the medics on the battlefield. This concept is not science fiction as medics in World War II carried freeze-dried plasma. To make DCR on the battlefield a reality, we will need lyophilized (freeze dried) blood components and monitors that will be able to assist the combat medic in the diagnosis of hemorrhagic shock in young, well-conditioned patients with great compensatory systems. These monitors will also guide the medic during DCR.

Boosting the JTTS

The JTTS has greatly enhanced the organization of trauma care in trauma zones, especially with the advent of the joint theater trauma registry. The joint theater trauma registry,

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by providing us with snapshots of both injury patterns and outcomes, has helped us to track trends over time. Our challenge now is to complete the registry and add specific injury pattern modules that will allow for detailed epidemiology to direct process improvement, research, and protective efforts. Data on the impact of evacuation time on specific injury patterns will help guide indications for DCR for medics. We currently have no prehospital data for the combat wounded and we must find a system for accurate documentation of prehospital care that medics will buy into. We must also track long-term follow-up and surveillance of treatment outcomes for the unique mechanisms and wounding patterns of combat, austere surgery, and global evacuation to help us anticipate unforeseen problems after being wounded in combat.

Monitoring Combat Burn Care

Severely burned combat casualties are prone to under- or over-resuscitation due to multiple physicians and multiple facilities overseeing their burn resuscitation during global evacuation. The institution of a simple burn "flowsheet" to record intravenous fluids and urine output has resulted in a lower rate of over-resuscitation and its inherent complications. We must now advance the science of burn resuscitation with computer-enhanced open loop burn resuscitation.

Tactical Combat Casualty Care

Tactical combat casualty care has made great advances: tourniquets, care under fire, needle decompression, and hypotensive resuscitation are the mainstay of current teachings and have saved innumerable lives on the battlefield. Maintaining our momentum and continuing to make improvements in all of the aforementioned areas will pave the way for the next generation of devices and methodologies that may include a truncal tourniquet for "compressible nontourniquetable" arterial hemorrhage, DCR with lyophilized blood components, ultrasound with computerized color enhancement to diagnose free intraperitoneal blood and free intrapleural air, improved resuscitation fluids for brain injured, open and closed loop optimal ventilation for brain injured, monitors that diagnose hypovolemic shock and that will guide resuscitation, accurate documentation of prehospital care by medics, possibly with computerized voice recognition, and a reliable battlefield airway.

To The Right

As we push DCR to the "left" onto the battlefield we must be able to handle the increased injury severity of the combat wounded surviving evacuation to deployed surgical facilities "to the right." This will require advances in inflammatory mechanism amelioration, infection control/treatment, and regenerative medicine. All these areas represent the next generation of advances in combat casualty care.

Our motivation to overcome the inherent challenges in the next generation of combat casualty care and to make these ideas reality is not mere hyperbole. We are driven by the searing images stored in our collective memory: the soldier we might have saved, the limb we could not salvage, or perhaps most poignantly, the military chaplain knocking on the door of a 26-year-old spouse with two young children.